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CIRCULAR No. 18

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THE WHITE FLY
AND ITS TREATMENT

BY

ARTHUR H. ROSENFELD

ISSUED UNDER THE DIRECTION OF THE

STATE BOARD OF AGRICULTURE AND IMMIGRATION

CHAS. SCHULER, Commissioner

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STATE CROP PEST COMMISSION OF LOUISIANA.

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FIG. 1.—Spraying orange trees for white fly, with bucket spray pump having extension rod attachment and extra long hose (Original).

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State Crop Pest Commission

OF LOUISIANA.

CIRCULAR No. 18. JULY 15, 1907.

The Circulars of the State Crop Pest Commission are sent free of charge to all farmers and fruit growers of Louisiana who make application therefor.

The White Fly* and Its Treatment.

BY ARTHUR H. ROSENFELD.

INTRODUCTION.

The white fly, or mealy wing, as it is sometimes called, is, in connection with the sooty mold of the orange which it indirectly causes, one of the worst enemies to citrus plants in Louisiana. It was first brought to the attention of entomologists in the orangery of the U. S. Department of Agriculture at Washington, D. C. It is not positively known where the original home of this little insect is, some well-known scientists inclining to the belief that it is a native of Florida, while other equally well-known authorities contend that the original habitat must be in Australia or Asia.

It is abundant in Louisiana from Baton Rouge southward. It is thought very probable that it was introduced into Louisiana during the New Orleans Exposition in 1885. Since that time it has spread considerably, and is now a very common insect in probably all of the orange-growing parishes of the State, with the exception of Cameron and Plaquemines. It has been reported from six states, namely, District of Columbia, Florida, Georgia, Louisiana, North Carolina, and Texas.

*_Aleyrodes citri_ R. & H.

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DESCRIPTION.

Most fruit growers in the infested districts are familiar with at least the larval stages of the white fly. The life of the insect, as is the case with most insects, is divided into four distinct periods, viz., the egg stage, the larval or nymphal stage, the pupal or resting stage, and the adult or fly stage.

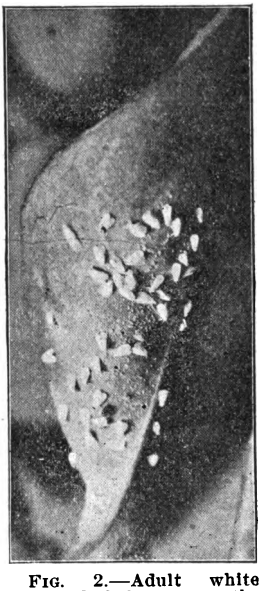

FIG. 2.—Adult white flies and their eggs on the under side of an orange leaf (After Gossard, Bulletin 67, Fla. Exp. Station).

The eggs are very small, being about one-one hundred and twenty-fifth of an inch in length, about four times as long as broad, and attached to the leaves by a slender stem. They are pale yellow when first laid, but gradually darken as the young insects develop within. When the egg is about to hatch, the little red eyes of the embryonic larva can be plainly seen through the egg-covering.

From the egg hatches a tiny, pale greenish-yellow insect about one-eightieth of an inch in length. This little larva sheds its skin (which process is known as "moulting") four times in the process of growth before it reaches the pupal stage, at which time it is about three-fiftieths of an inch in length and two-fiftieths of an inch in breadth. It is during the larval and pupal stages that these insects resemble scale nsects so closely. They are not really scale insects, but belong to a very closely related family (Aleyrodidae).

The pupal stage resembles the mature larvae so closely that it is difficult for the ordinary observer to distinguish them. The insect is about the same size at this stage as at the last, except that it is slightly narrower.

The adult has quite a different appearance. When the insect breaks its pupal case and comes forth as a mature insect it has undergone a wonderful transformation and in no particular resembles any of the former stages. From the comparatively helpless, flattened little creature, having almost no visible organs,

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there issues a beautiful little four-winged fly, the wings of which soon become covered with a fine waxy secretion, giving them their characteristic appearance, and suggesting the name of "mealy wing." When they first emerge they are a light orange-yellow in color, but within a couple of hours assume the mealy appearance. The female is about one-twentieth of an inch in length; the male somewhat smaller.

LIFE HISTORY.

The first brood of adult flies issues scatteringly through March, April and early May. They love closely sheltered groves and as a rule it will be found that well-planted open groves are not as badly infested as closely set, unpruned groves. The flies pair very soon after emergence and the females generally begin depositing eggs in from 12 to 30 hours. In case of cold weather, however, they may delay oviposition for several days. They do not, as a rule, lay their eggs in any certain position relative to each other, but this sometimes occurs. They always choose the under side of the youngest and most tender leaves, except in cases of bad infestation, when old leaves will be covered with eggs also. The eggs will generally be found thickest toward the center of the leaf. Each female lays from 17 to 25 eggs, depending upon the temperature, warm weather being conducive to prolific oviposition, and cold weather *vice versa*. Prof. Gossard calculated that the number of eggs on a single leaf taken from a grove at Myers, Fla., was 20,000, and this is a conservative estimate. This will serve to give some idea of the enormous reproductive capabilities of these insects.

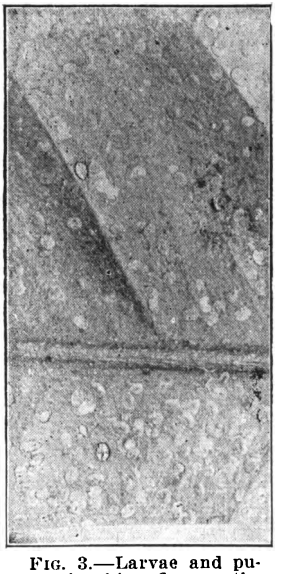

FIG. 3.—Larvae and pupae of white fly on the under side of an orange leaf (After Gossard Bul. 67. Fla. Exp. Station).

The eggs hatch in from three to twenty days, depending

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upon the temperature. It might be said here that in all insect, as well as in plant life, cold weather retards development.

The young larvae, when hatched, crawl about over the leaves and twigs for several hours before attaching to the leaves. Under normal summer conditions the insect will pupate in from twenty to thirty days after hatching, and the full grown fly will emerge in from ten to thirty days afterwards. We thus see that the life history of one brood, from the time that the egg is laid until the adult insect emerges, will range from forty to fifty days in the summer to six months in the winter.

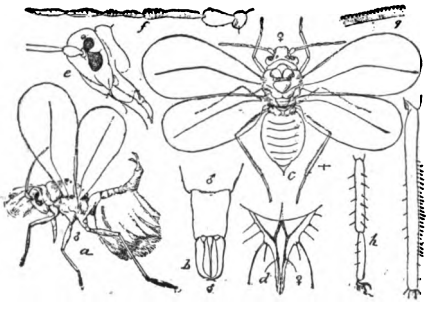

FIG. 4.—White fly (*Aleyrodes citri*); *a*, winged male insect, with enlarged view of terminal segments at *b*; *c*, dorsal view of winged female, with enlargements of ovipositor, head and antenna, wing margin, and leg at *d*, *e*, *f*, *g*, *h*, *i*, (After Riley and Howard, courtesy U. S. Dept. of Agriculture, Bur. of Entomology).

When the adult insect is ready to emerge the pupal skin splits in the form of a cross, and the soft little fly comes forth. When they first issue the flies are damp and comparatively helpless, but in the course of an hour or two the body and wings harden, and the insects begin mating soon afterwards.

There are three broods each year with the possibility of a fourth in exceptionally warm and lengthy seasons. There is always, however, a certain amount of continuous breeding, so that all stages of the insect can generally be found at the same time upon a badly infested tree, except during the cold winter months.

NATURAL ENEMIES.

The only natural enemies of the white fly which show any likelihood of exerting much influence in holding this insect in check are several fungous diseases, known as the Red Ascheronia. the Brown Fungus, and the Yellow Ascheronia. Of these the first two have been introduced into Louisiana, and it is probable that in many cases, they will make spraying unnecessary in a few years. All of these fungi have done a great deal of good in Florida, numbers of the large orange growers there depending upon the fungi entirely for control of the white fly.

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As yet we know little of these fungi in Louisiana, but there seems no reason why they should not be just as effective in this state as they are in Florida. The conditions in Louisiana, especially the extreme humidity which exists in all of the orange-growing parishes, are very favorable for the multiplication of fungi. We are now conducting at several points in the State, experiments with the Red Ascheronia and the Brown Fungus. In 1906 we introduced these fungi, obtained from the Manatee section of Florida, into orange groves at Lake Charles, New Orleans, Amite, Naomi, and Nairn, but, on account of the drouth of last season, most of the fungus died out. However in two places, notably at Lake Charles, and in a grove in Jefferson Parish, the fungi have become well established, and during the past winter killed about 95 per cent of the white fly upon the trees infected with the fungus. Using these two places as a source of supply, we are conducting more experiments with the fungi this year, and, with a favorable season, hope to get them well established in a number of places in the State.

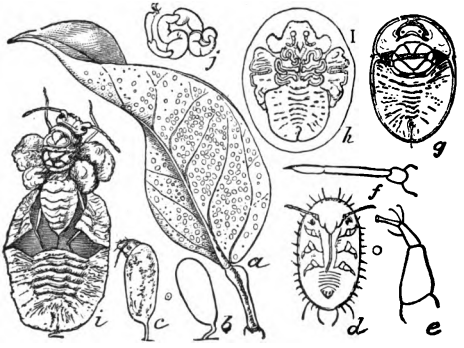

FIG. 5.—White fly (*Aleyrodes citri*); *a*, orange leaf, showing infestations on under surface—natural size; *b*, egg; *c*, same, with young insect emerging; *d*, larval insect; *e*, foot of same; *f*, larval antennae; *g*, scale-like pupa; *h*, pupa about to disclose adult insect; *i*, insect escaping from pupal shell; *j*, leg of newly emerged insect, not yet straightened out and hardened—all figures except *a* greatly enlarged. (After Riley and Howard, courtesy U. S. Dept. of Agriculture, Bur. of Entomology).

SOOTY MOLD.

Many orchardists have noticed a sooty or smutty appearance of their orange trees without knowing that this directly follows the attack of the white fly. The white fly is one of a class of insects which have the faculty of excreting, through the pores of their little bodies, a sweet substance called honey-dew. This honey-dew falls upon the leaves beneath the feeding insects, and becomes the growing place for minute plant organisms called fungi. The sooty mold of the orange is caused in just this man-

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ner. The spores of the sooty fungus, which in general function correspond to the seeds of higher plants, are carried by the wind or other natural agencies, and fall upon this honey dew. They soon germinate and begin to grow, gradually covering the entire upper surface of the leaf with a fine, black, filmy covering, which can often be rubbed from the leaf as if it were a piece of tissue paper. The fungus does its injury, not by destroying directly the essential juices of the plant, but by covering up the openings of the leaves and preventing the absorption of plant food from the air. Thus it is readily seen that by getting rid of the white fly one will at the same time rid the trees of a most unsightly and injurious disease.

SPRAYS.

While we cannot hope to *entirely* eradicate any insect from fruit trees, we can, by judicious spraying, so keep down the white fly that the injury from both the insect and fungus will amount to almost nothing. Either one of the following formulae will prove effective *if properly applied.* They are recommended by Prof. H. A. Gossard in Bulletin 67 of the Florida Agricultural Experiment Station Prof. Gossard's directions for preparation of these washes are as follows:

1. Resin, pulverized .....20 pounds.
   Caustic Soda, granulated, 98 per cent...4 1-4 lbs.
   Fish Oil.....3 pints.
   Water for final bulk.....150 gallons.

"Ordinary commercial resin, such as is bought by the barrel in Florida, is satisfactory, and is best purchased in small packages, the entire contents of which can be used at once after opening, for this substance rapidly absorbs moisture from the air, and therefore loses its effectiveness if left exposed.

"Another formula which has given good satisfaction to some growers because of the convenience of quickly obtaining the materials without ordering them from a distance, and of keeping the soda indefinitely without special precautions is as follows:

2. Resin .....20 pounds.
   Caustic Soda (Star Ball Potash) pulverized
   .....7 pounds.
   Fish Oil.....3 1-2 pints.
   Water for final bulk.....100 gallons.

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* * * "As a smothering wash formula 1 is probably equal to 2, but its contact effects are less satisfactory. If the wash is to be used in summer the dilution is about right, but for winter use better results are secured by diluting to 100 gallons instead of to 150.

* * * "The details of preparation are the same no matter which formula is used. Procure a large iron kettle, a hog scalding vat is excellent, and another smaller kettle for hot water. If a large kettle of from twenty-five to forty gallons capacity is unavailable, a number of smaller ones can be used, the materials being divided between them as they are weighed out and measured. Heat in the large kettle thirteen or fourteen gallons of water, having previously placed the materials given in one of the formulae in the bottom. If the water is hot before the materials are put in, add the resin and fish oil first, and then the soda in small lots to prevent a sudden boiling over. Boiling is best continued for two or three hours over a hot but not too brisk fire. * * * Whenever there is a tendency for the liquid to boil over, subsidence can be quickly obtained if a pint or more of water from the water kettle, which is kept warm but not boiling, is added. Never add cold water while the wash is cooking if you desire results that are certain. Increase the quantity of solution by gradual additions of warm water until a stock solution of thirty gallons is obtained. For use, this is to be diluted to 100 or 150 gallons as called for by the formula used. The stock solution may be kept for a time and used as desired, but the wash is best used as fast as made. Any sediment or settling in the stock solution indicates that the cooking was incomplete and must be repeated. * * The stock solution should be strained before diluting it to remove any particles of trash that would clog the pump nozzle."

The Crop Pest Commission is now conducting extensive experiments in New Orleans, in co-operation with the State Experiment Stations, using twenty different spraying solutions for the control of the white fly and the purple scale so common on Louisiana oranges. We are trying to find the solution which is most efficient against both the white fly and the purple scale, thus combining the treatment for these two insects. The resin

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washes, recommended above, seem equally effective against both of these pests, and are the most effective sprays we know of at present. We hope to publish the results of these spraying experiments within the year.

In the treatment of the white fly it is very important to understand when to apply the sprays. Two applications should be made between December and the first of March, all fruit being removed before the wash is applied, in order to prevent burning. In the case of badly infested groves, three applications may be made with profit, at intervals of from ten days to three weeks, during this period. If these treatments are thoroughly made summer treatment will probably be unnecessary. If possible it is always best to avoid summer treatments of orange groves, as a wash which is strong enough to kill the insects is very likely to injure the fruit or foliage in the summer.

FIG. 6.—A serviceable home-made strainer for straining resin mixtures. Made by placing wire cloth in an ordinary water bucket and inserting a piece of gas pipe in the bottom. (From a photo by W. E. Britton, Conn. Exp. Station.)

SUMMER TREATMENT FOR THE WHITE FLY.

While, as pointed out above, there is no spray that can be used in the summer as a satisfactorily efficient agent against the white fly, still it sometimes becomes necessary to apply a wash of some sort in the summer in order to keep badly infested trees alive until winter treatment can be undertaken. Infestations are sometimes discovered in the summer which are so severe as to make it necessary for the owner to either treat at once or lose the trees. In such cases about three applications of the sulphur and whale oil soap mixture, recommended by Professor H. A. Gossard in Bulletin 67 of the Florida Agricultural Experiment Station, or of a fifteen per cent kerosene emulsion, will prove effective in holding the pest sufficiently in check to keep the trees alive until a stronger wash can be applied.

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To make the sulphur and whale oil soap mixture, dissolve one quart of flowers of sulphur by boiling with ten pounds of whale oil soap in fifteen gallons of water, cooking well until all sulphur is dissolved, and then diluting to thirty-five gallons.

Kerosene emulsion is made from four pounds of whale oil soap (or good laundry soap), four gallons of water, and eight gallons of kerosene oil, as follows: Weigh the soap carefully and place with the water in a vessel over a fire, using a slight excess of water to allow for the evaporation incident to boiling. Fit a pump with a straight piece of hose, to which is attached a nozzle for throwing a straight stream 3-16 or 1-4 inch in diameter. Pour the oil into the vessel in which the pump is set, and when the soap is dissolved and the solution begins to boil, add it to the oil (AWAY FROM THE FIRE), and pump the whole vigorously back and forth into itself for at least ten minutes. The stream from the nozzle should be directed straight into the mixture, so as to agitate it all the way to the bottom. After a few minutes the oil and soap solution will be seen to combine, forming a thick, creamy solution, which, if properly made, will remain unchanged for some time. For a 15 per cent strength add, when ready to use, enough water to make 54 gallons. If a 20 per cent emulsion is desired, add water to make 40 gallons, and for a 10 per cent emulsion, add water to make 80 gallons.

Whale oil soap can be secured from James Good, Philadelphia, Penn., or from the J. Steckler Seed Co., Ltd., 516-520 Gravier St., New Orleans, La. The latter is the only firm in Louisiana which we know to handle this substance.

Summer spraying should never be commenced before the first or second week in June, as, previous to that time, the fruit is very susceptible to injury. If the trees are very badly infested, this spraying should be repeated about the middle of July, and again toward the latter part of August. Both of the above washes will kill a number of scale insects, and the sulphur and whale oil soap mixture is particularly valuable, as it materially assists in holding rust in check.

HOW TO SPRAY AND WHAT TO USE.

Too much emphasis cannot be placed upon the necessity of spraying *properly* against the white fly. As these insects live almost without exception upon the *under* surface of the leaves,

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it is absolutely essential that the spray be made to reach, as nearly as possible, all parts of this surface. At first it will be found a little difficult to do this thoroughly, but, after a little practice in handling the nozzle this will be a comparatively easy task. In order to cover every portion of the tree without the operator getting himself well covered with the spray, and also wasting quite a quantity, spraying should be commenced near the center of the tree and finished at the outside. Any pruning that is desired should be given before applying the wash, firstly, because the spray can be more easily made to reach all parts of the trees, and secondly, because of the direct saving in amount of spray which would otherwise be applied to the useless portions of the trees. It should be borne in mind that the object of spraying is to touch every single white fly with the wash, and that every white fly which is not so touched will simply act as a parent for another brood.

For the average large grove an ordinary barrel pump, mounted on a wagon or cart, will be all the outfit necessary, while in large commercial groves, power sprayers may be used to advantage; the wash, in this case, being best cooked by steam. For small groves and trees in yards the most economical and efficient apparatus is an ordinary bucket pump, such as is shown in Fig. 1, the price of which is about six or eight dollars.

In all cases the pump should be equipped with bamboo extension rods, except in the case of the bucket pumps, on which six foot iron extension rods will answer. All pumps should be furnished with a good length of rubber hose and Vermoral nozzles.

Special attention is called to the necessity of having a sufficient length of hose attached to all pumps. As usually sold, the length of hose attached to pumps is wholly inadequate, and the buyer should always specify that a certain length of hose shall be furnished before the pump will be accepted. For the bucket pumps about ten feet of good quality hose should be insisted on, while for the larger pumps about fifteen to twenty-five foot lengths will be necessary for best results. As usually sold, only about three feet of hose are furnished wth bucket pumps, which makes it impossible to do good work with them on anything larger than a small garden plant.

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Two persons should always be employed when spraying trees, as it is impossible for one man to do a thorough job. One person should do the pumpng, while the other handles the nozzle.

Below are given the names and addresses of several manufacturers of reliable spray pumps, any of whom will furnish catalogues and price lists upon application.

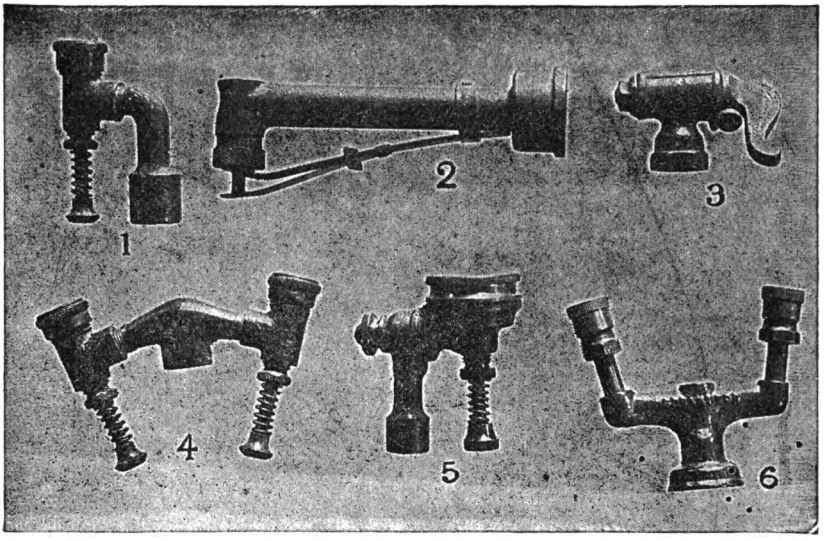

FIG. 7.—Common types of spray nozzles: 1, Vermorel; 2, McGowen; 3, Bordeaux; 4, Double Vermorel; 5, Mistry; 6, Double Spray-motor. (After Britton, Conn. Exp. Station Bulletin.)

Morrill and Morley, Benton Harbor, Mich.

The Deming Co., Salem, Ohio.

Goulds Manufacturing Co., Seneca Falls, N. Y.

Spray-Motor Co., Buffalo, N. Y.

Field Force Pump Co., Elmira, N. Y.

P. J. Berckmans Co., Augusta, Ga.

Beck and Gregg Hardware Co., Atlanta, Ga.

J. Steckler Seed Co., 516 Gravier St., New Orleans, La.

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STATE CROP PEST COMMISSION REGULATIONS REQUIRING DEFOLIATION OF CITRUS NURSERY STOCK.

Section XI of the Rules and Regulations * of the State Crop Pest Commission of Louisiana, reads as follows:

"All orange, lemon, lime, sweet lime, kumquat, tangerine, and grape-fruit trees or plants sold or shipped within this State, or delivered within this State when shipped from another State or country, shall be completely defoliated. Shipments of such trees or plants, not so defoliated, intended for delivery within this State, when found in possession of any common carrier, corporation, firm, person, or agent, or when found exposed or offered for sale within this State, shall be subject to confiscation by the Entomologist or his assistants or inspectors."

Some dealers at first rather objected to this Regulation, principally upon two grounds, viz.,—that defoliated trees would not sell as readily as trees not so defoliated, and secondly, that defoliated trees will leaf out sooner than undefoliated trees, and would, therefore, be more liable to injury by frost. While both of these arguments have a certain amount of validity, the arguments for the other side may be summed up in a few words by saying that the chances for benefit under this Regulation are so much more numerous than the chances for injury, that it would be almost foolish not to have this Regulation. Besides this, when a customer is assured that his trees, when leaved out, will be clean and green instead of covered with the unsightly smut, there should be very little difficulty in selling the trees.

Naturally, in an infested region, the trees, even if defoliated, will sooner or later become infested, but they will get a much stronger growth before this infestation than they otherwise possibly could.

It is very doubtful after all, if defoliation renders a tree more subject to death by frost, and there is even good reason for supposing that a defoliated tree is really more dormant than one upon which the leaves are performing their normal function and thus keeping a certain amount of sap in circulation. The

*Issue of July 1, 1907. (See Circular 17 of the Commission.)

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experiments of the Audubon Park Experiment Station bear out this conclusion. A few years ago Mr. Blouin had a defoliated tree to stand a temperature of 15 degrees at Baton Rouge, while trees from the same lot and planted at the same time, but not defoliated, were killed to the ground.

It has now been several months since this "defoliation Regulation" was placed in effect by the Commission, and New Orleans nurserymen report to us that not only are shipping and handling expenses reduced by defoliating the citrus trees, but that their customers, realizing the benefits following defoliation, willingly accept defoliated trees in preference to others.

SUMMARY.

1. The white fly is one of our most common and injurious insects on citrus plants. Its original habitat is not known with certainty. It was first noticed in the orangery of the U. S. Department of Agriculture. It is thought that it was first introduced into Louisiana during the New Orleans Exposition in 1885. It is now known in six States.

2. The life of the insect is divided into four distinct stages, viz., the egg stage, the larval stage, the pupal stage, and the adult stage.

3. Temperature influences greatly the length of different stages, and therefore probably the number of generations per year. Under normal conditions the insect will pupate in from twenty to thirty days after hatching, and the full grown fly will emerge in from ten to thirty days afterwards. There are generally three broods, but with an exceptionally warm summer and fall there may be four.

4. The Red Ascheronia, Brown Fungus, and the Yellow Ascheronia, three fungi, are doing a great deal toward holding the white fly in check in certain localities in Florida. These fungi are being introduced into Louisiana by the State Crop Pest Commission.

5. Sooty mold is caused by fungi breeding in the sweet excretions of the white fly. This sweet excretion, or honey-dew,

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falls upon the upper surface of the leaves, and the sooty mold is there most abundant. When the white fly is disposed of, the sooty mold also disappears.

6. The resin washes recommended by Prof. H. A. Gossard of the Florida Experiment Station have thus far proven the most efficient sprays against the white fly. Experiments are now being conducted at the Audubon Park Experiment Station with different sprays for this insect and the purple scale.

7. Complete defoliation of all citrus nursery stock before sale or shipment in Louisiana is required by the Regulations of the State Crop Pest Commission, and prevents distribution of the white fly to localities still free from the pest.

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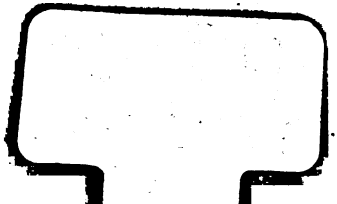

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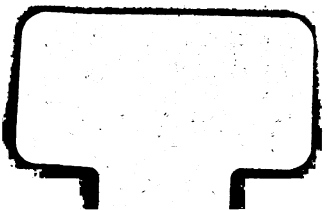

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